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Data reduction of GOES information from DCP networks

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RIM
RIVER ICE MANAGEMENT

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A software system, DCP.FOR, was developed to provide a convenient and efficient method of decoding, reducing, and storing data from Data Collection Platform (DCP) networks transmitted through the Geostationary Operational Environmental Satellite (GOES) data collection system. The software system includes a simple means of defining the arrangement of sensors at a DCP site that can be easily updated if the sensor arrangement is changed or the sensors modified. Any linear data reduction procedure can be processed. Precise temperature measurements using individually calibrated thermistors can be processed through the use of voltage divider circuits, nonlinear resistance to temperature calibration, and impedance mismatch detection and correction. The system can process data from DCPs manufactured by four companies. User-defined maximum and minimum limits determine the acceptability of the processed data. Data values not within these limits or missing data are flagged with a missing value marker. The database created by the system is independent of the particular sensor arrangement at any DCP site. The data can be easily transferred to other database systems.

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PREFACE

This report was prepared by Gary W. DeCoff, Telecommunications Specialist, Information Systems Branch, Information Management Division; Steven F. Daly, Research Hydraulic Engineer, Ice Engineering Research Branch, Experimental Engineering Division; Timothy Pangburn, Research Hydraulic Engineer, and Clay Thomson, Physical Sciences Technician, Geological Sciences Branch, Research Division, of the U.S. Army Cold Regions Research and Engineering Laboratory. This work was funded under the River Ice Management Program, Work Unit CWIS 32296, *Ice Forecasting for Navigable Waterways*, and CWIS 32228, *Remote Sensing Ice Monitoring System*.

The authors thank Charles Clark of USACRREL for providing needed field support. This report was technically reviewed by Dr. H. McKim and Gregor Fellers.

The program listing for DCP.FOR, in hard copy and on a 5.25-in. disk, is available as Internal Report 1037 from the USACRREL Library.

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Data Reduction of GOES Information from DCP Networks

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INTRODUCTION

The use of Data Collection Platforms (DCPs) to transmit data through the Geostationary Operational Environmental Satellite (GOES) data collection system is becoming increasingly widespread as the ability to process and use real-time data expands. The data are essential for reservoir regulation, navigation, ice forecasting, flood forecasting, water-quality monitoring, and other facets of the Corps of Engineers mission. Each DCP may be interfaced with many different sensors, depending on the objective. The sensors may be moved from location to location and may be recalibrated or reconfigured. An efficient and flexible decoding and data reduction system must be used to determine the actual engineering values of measurements from a large number of sensors and to store the data in a convenient and useful data-base. For analysis programs, the storage database from which information is extracted must have a fixed format that does not change regardless of the changes made to the sensors. In short, the need has arisen for software that is efficient in reducing and storing DCP transmission data in a usable format and flexible enough to allow changes in sensor and transmission formats to be incorporated easily.

This paper describes a software system, DCP.FOR, that was developed at USACRREL to provide a convenient and efficient method of decoding, reducing, and storing data from DCP networks. The software system includes a simple means of defining the arrangement of sensors at a DCP site that can be updated easily if the sensor arrangement is changed or the sensors modified. Any linear data reduction procedure can be processed. Voltage divider circuits can also be processed to determine the resistance of thermistors, from which the temperature of the thermistor can then be calculated through the use of the nonlinear Steinhart–Hart equation. If reference resistors are installed in the voltage divider circuit, the transmitted value of the thermistor resistance can be corrected for any impedance mismatch, based on the transmitted value of the reference resistor. The system can process data from DCPs manufactured by four different companies: Sutron, Synergetics, Handar, and Lebarge. The program will also check to see if the data value is within user-specified maximum and minimum limits. If it is not, the value will be flagged with a missing value marker. The database created by DCP.FOR is independent of the particular sensor arrangement at any DCP site. It provides a convenient way of interfacing the data collection network with application programs.

DCP.FOR DESCRIPTION

An overview of DCP.FOR is shown in Figure 1. The program consists of three parts. The first part is MASTER.DAT, an information file that describes each DCP site. MASTER.DAT contains information describing the DCP type, GOES identification codes, sensor types, linear data reduction constants, thermistor calibration constants, and more. If a DCP site is updated or changed in any manner, only the information in MASTER.DAT need be changed.

The second part is the program DCP.FOR itself. DCP.FOR uses the data in MASTER.DAT to select the appropriate information in the GOES message, performs the required data reductions,

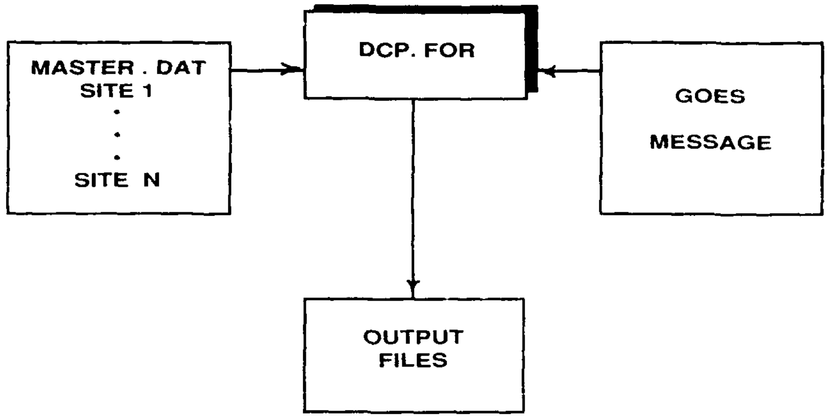

Figure 1. DCP.FOR program structure.

and stores the information in engineering units in an output file, the third part of the program.

A separate output file is created for each site and contains a month-long record. The output files record the date, time, and value of each sensor. Values are stored in engineering units, and missing data are indicated by a missing data value.

DATA REDUCTION

DCP.CONVERT can process a maximum of 25 DCP sites. Each site can have up to 16 sensors. DCP.FOR determines thermistor temperatures by use of the Steinhart–Hart equation, which is a third-order polynomial describing the inverse of the temperature in terms of the natural logarithm of the thermistor resistance. Up to 4 sets of polynomial coefficients (referred to as calibration constants) can be specified for each site. DCP.FOR can process data from Sutron, Synergetics, Handar, and Lebarge DCPs. A short description of the reduction procedures and the sensor types the program can process follows.

Linear data reduction

DCP.CONVERT can process the data from any sensor that requires a linear data reduction equation of the form

$$E = Slope\,(x) + B \tag{1}$$

where E is the sensor output in engineering units, x is the value transmitted by the DCP, and *Slope* and B are the user-supplied slope and intercept of the linear relationship between the DCP transmission and the associated sensor output in engineering units. The DCP transmission will be a coded form of the voltage output of the sensor.

Voltage divider circuits

Generally the most accurate measurement of air or water temperature is accomplished by means of a thermistor, which changes resistance in response to changes in temperature. However, as DCPs cannot measure resistances, a voltage divider circuit must be used to measure the voltage across the thermistor. An example of a voltage divider circuit is shown in Figure 2. The resistance of the thermistor, R_T, can be calculated by

$$R_T = R_D \frac{V_T}{V_O - V_T} \tag{2}$$

where R_D is the known resistance of the divider resistor, V_T is the measured voltage across the thermistor, and V_O is the measured applied excitation voltage across the circuit.

Correction of Measured Voltage for Impedance Mismatching

Due to the present design of DCPs it is not always possible to construct simple voltage divider circuits that provide maximum accuracy, minimum self-heating, and proper impedance matching. Impedance mismatching together with relatively large common mode offset currents that are introduced into the voltage divider

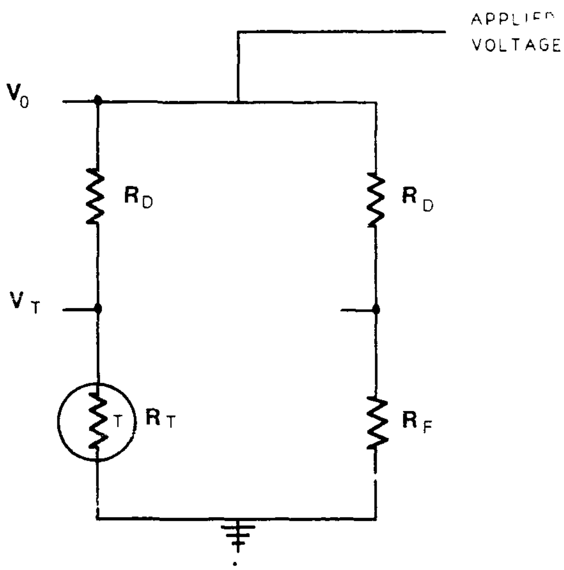

Figure 2. Voltage divider circuit for determining thermistor resistance. See text for explanation of variables.

circuits by the circuitry of the DCP can result in inaccurate calculation of the thermistor resistance by eq 2. To correct for the offset current, the voltage across a reference resistor with a known stable resistance is measured along with the temperature thermistors. This measurement allows the offset current produced by the impedance mismatching to be determined. The voltage across the reference resistor V_F can then be used to calculate each thermistor resistance by

$$R_T = R_F \frac{V_T}{2\,V_F - V_T} \qquad (3)$$

where R_F is the known resistance of the reference resistor.

Steinhart–Hart equation

The Steinhart–Hart (1968) equation is an empirical equation that relates the resistance of the thermistor to its temperature. It is a third-order polynomial describing the inverse of the temperature in terms of the natural logarithm of the resistance. It has been found that the second-order term of the polynomial can be neglected. The equation is

$$\frac{1}{T} = a + b\ (\ln R_T) + c\,(\ln R_T)^3 \qquad (4)$$

where a, b, and c are constants determined from calibrating the thermistor, R_T is the thermistor resistance, and T is the thermistor temperature in kelvins. The resistance of the thermistor is accurately measured at three known temperatures during calibration. The Steinhart–Hart equation is then fitted to the results and the values of the use of the a, b, and c constants are determined. DCP.FOR allows up to four sets of calibration constants at any site.

SENSORS

The following is a list of the sensor types that DCP.FOR is specifically designed to process.

Temperature

Generally glass-in-bead type thermistors are recommended for water and air temperature measurements. Currents through the thermistor must be kept low to avoid self-heating of the thermistors. For best accuracy, individually calibrated thermistors should be used.

A platinum resistor may also be used. This is a sensor in which the resistance change is linear with temperature change over a fairly wide temperature range. In either case a voltage divider circuit is required.

Relative humidity

Relative humidity sensors can be of several types. Generally, their output is a voltage linearly proportional to the relative humidity. The units are percent of maximum.

Solar radiation

Solar radiation sensors measure the flux of the shortwave radiation of the sun. Their output is a voltage linearly proportional to the solar energy flux. Units are watts per square meter.

Barometric pressure.

Barometric pressure sensors measure the pressure of the atmosphere. Their output is a voltage linearly proportional to the atmospheric pressure. Units are millibars.

Wind speed

The output of wind-speed sensors is a voltage linearly proportional to the wind speed. Units are meters per second.

Wind direction

Wind-direction sensors produce a voltage linearly proportional to the direction of the wind, which usually ranges from 0° to 540°. The units are degrees.

Water level (float)

Measurement of water stage with DCPs is most often accomplished by using a float placed in a stilling basin attached to the shaft of a shaft encoder. Movement of the float turns the shaft; this is detected by the shaft encoder, which is interfaced with the DCP. Output is normally in digital form. Units are in feet or meters above a datum.

Water level (pressure transducer)

A pressure transducer measures the water surface stage by sensing the pressure caused by the weight of the water above it. Output is a voltage that is linearly proportional to stage. Units are in feet or meters above a datum.

Water level (acoustic sensor)

Acoustic sensors measure the time required for a sonic wave to travel to the water surface and return. The sensor may be mounted above or below the water surface. As the wave speed in air and/or water is well known, the distance to the air/water boundary can be calculated and the water surface stage determined. Output is usually a voltage proportional to the travel time. Units are in feet or meters above a datum.

Battery voltage

The DCPs are powered by batteries that are kept continuously charged if 110V power or solar panels are available. Power may also be supplied by solar panels. The state of the DCP can be monitored by transmitting the battery voltage. Output is a voltage that is linearly proportional to the battery voltage. The units are volts.

MASTER.DAT

The file MASTER.DAT contains a description of each DCP site. Each description consists of four parts: the site information, transmission information, sensor description, and thermistor calibration information. The description is repeated as necessary to describe all the DCPs in a network. The site information contains a site title, site code, GOES identification number, and DCP type. Transmission information describes the number of channels transmitted, number of lines in a transmission, number of redundant lines, position in the transmission of the battery voltage information, and number of groups of thermistor constants. The sensor description identifies the sensor and the reduction constants if the reduction is linear, or indicates the thermistor calibration group that contains the appropriate calibration constants if the sensor is a thermistor. The maximum and minimum allowable data values are also included.

Specifically, the MASTER.DAT file is arranged as follows:

1. LOCATION — Descriptive name of DCP site.

2. SITE — Four-character code assigned each DCP site.

3. SN — GOES identification number.

4. DCPTYPE — Three-character code for type of DCP

Sutron	SUT
Synergetics	SYN
Lebarge	LEB
Handar	HAN

5. NC, NL, NLR, BVL, NGC

NC	Number of channels of transmitted data (not including battery voltage channel)
NL	Number of data lines in the transmission
NLR	Number of redundant data lines
BVL	Battery voltage line
NGC	Number of groups of thermistor calibration constants

6–21. SENCODE(I), SLOPE(I), B(I), XMAS (I), XMIN(I), TG(I)
SENCODE — Descriptive number identifying the sensor

1 = VO — Voltage reference
2 = Water temperature (volts, nonlinear)
3 = Reference resistor (assumed to be 10K ohm)
4 = Air temperature (volts, nonlinear)
5 = Relative humidity
6 = Solar radiation
7 = Barometric pressure
8 = Wind speed
9 = Wind direction
10 = Stage (float)
11 = Water depth (pressure transducer)
12 = Water depth (acoustic sensor)
13 = Battery voltage
14 = Water temperature (linear)
15 = Air temperature (linear)
16 = Water temperature (ohms, nonlinear)
17 = Air temperature (ohms, nonlinear)
18–20 = Unused channels

SLOPE = Factor by which data is multiplied
B = Number added to (data) x (slope)
XMAX = Maximum value of data
XMIN = Minimum value of data
TG = Thermistor constant group; if TG = 0, ignore

22–24. WA, WB, WC

WA = *a* constant in Steinhart–Hart equation
WB = *b* constant in Steinhart–Hart equation
WC = *c* constant in Steinhart–Hart equation

An example from MASTER.DAT is shown in Table 1. A complete file listing is contained in Appendix A. Whenever a sensor or a new site is installed, only MASTER.DAT has to be edited.

DCP.FOR

The DCP.FOR program contains a main program and 19 modules. A description of the program follows.

Main Program

The main program first opens the GOES message file. MASTER.DAT is read and then the GOES message file is read, one line at a time. If a match with a DCP described in MASTER.DAT is found, subroutine MESSAGE is called, the data is processed, and the converted data is written to site-specific files. At the end of the program, the input file and all output files are closed.

Subroutines

1. Subroutine MASTER — Opens the master file MASTER.DAT, reads the site information for each DCP, and closes MASTER.DAT.

2. Subroutine MESSAGE — Consists of three sections:

a. The first section breaks each line of data into separate values. All lines in one site transmission are processed at one time.

b. The second matches the sensor to its appropriate constants and converts the raw value to engineering units.

c. The last section calls subroutine OUTPUT to write converted data to an output file.

3. Subroutine DECOD1 — Processes a data line from a Synergetics DCP.

4. Subroutine DECOD2 — Processes a data line from a Sutron DCP.

5. Subroutine DECOD3 — Processes a data line from a Lebarge DCP.

6. Subroutine DECOD4 — Processes a data line from a Handar DCP.

7. Subroutine MCON — Initializes a real array to a specified number.

8. Subroutine IMCON — Initializes an integer array to a specified number.

9. Subroutine DATEMAKE — Given the year, day, and hour from the first line of a DCP scan, converts the date into a required format.

10. Function IOPLEN — Returns the length of a character variable.

11. Function CONVERT — Converts a raw data value into an engineering value using a linear conversion.

12. Function TEMPER — Computes a resistance from the voltages of the voltage divider circuit and then calculates a temperature from the resistance.

13. Function RESIST2 — Computes a thermistor resistance using a correction based on reference resistor value.

14. Function TTEMPSH — Using the Steinhart–Hart equation, calculates a temperature from the resistance computed in RESIST2.

Table 1. Example of data contained in MASTER.DAT for Meldahl Locks and Dam

MASTER.DAT DESCRIPTION

```
Meldahl Locks & Dam
CRR1
CE4D678E
SYN
10,11,0,1,1
13,0.01,0.0,32000,0,0
3,10.0,0.0,32000,0,0
16,10.0,0.0,32000,0,1
16,10.0,0.0,32000,0,1
16,10.0,0.0,32000,0,1
15,0.1,0.0,32000,-30,0
5,1.0,0.0,32000,0,0
6,0.1162,3.2536,32000,-28,0
7,1.0,0.0,32000,0,0
8,0.0047,0.0,32000,0,0
9,0.1,0.0,3200,0,0
0.12827895D-2,0.23650902D-3,0.92066156D-7
```

DCP SITE DESCRIPTION

Location = Meldahl Locks & Dam
Site = CRR1
Serial Number = CE4D678E
DCP type = Synergetics
Number of channels = 10
Number of transmitted lines = 11
Number of redundant lines = 0
Battery voltage line = 1
Number of thermistor constant groups = 1

Channel	*Sensor code*	*Sensor*	*Slope*	*B*	*Maximum*	*Minimum*	*Thermistor group*
1	13	Bat.volt	0.01	0.0	32000	0	0
2	3	10K resist.	10.0	0.0	32000	0	0
3	16	Wat.temp.	10.0	0.0	32000	0	1
4	16	Wat.temp.	10.0	0.0	32000	0	1
5	16	Wat.temp.	10.0	0.0	32000	0	1
6	15	Air temp.	0.1	0.0	32000	-30	0
7	5	Rel.humid.	1.0	0.0	32000	0	0
8	6	Sol. rad.	0.1162	3.2536	32000	-28	0
9	7	Bar.pres.	1.0	0.0	32000	0	0
10	8	Wind sp.	0.0047	0.0	32000	0	0
11	9	Wind dir.	0.1	0.0	32000	0	0

Thermistor Constant Group 1:

a = 0.12827895D-2
b = 0.23650902D-3
c = 0.92066156D-7

15. Subroutine LETART — Does the calculations for a specific location, in this cast for the Letart Island site.

16. Subroutine OUTPUT — Writes converted data to the appropriate output file.

17. Function DATE$$ — Returns a Julian date or calendar date, depending on what is passed on.

18. Subroutine NEWMON — Opens a new output file each month.

19. Subroutine PRENTH — Prints the data in MASTER.DAT to the screen.

The DCP.FOR program is available on 5.25-in floppy disk. It may be obtained from CRREL as Internal Report 1037.

OUTPUT FILES

The processed data is written to files. One file is created for each month for each site. The name of each file contains the 4-letter site code (see line 2 of MASTER.DAT) followed by a period (.), the month, and the year. For example, the DEC. 1987 monthly file for Meldahl Locks & Dam would be CRR1.DEC1987. Each line of the data written to these files is in the following order: year, Julian date, hour, water temperature-1 (°C), water temperature-2 (°C), water temperature-3 (°C), 10K resistor (ohms), air temperature (°C), relative humidity (%), solar radiation (W/m^2), barometric pressure (mb), wind speed (m/s), wind direction (deg), stage (float) (m), stage (pressure transducer) (m), stage (acoustic sensor) (m), battery voltage (V), and spare. Any missing data is denoted by a -901. A new line of data is written for each hour of actual data. An example of an output file can be found in Appendix B, EMSP.FEB1988.

SUMMARY AND FUTURE WORK

A software system, DCP.FOR, was developed to solve the problem of reducing and storing data from DCP networks where sensors interfaced with the DCPs may be frequently modified. This is especially useful during the development of an application program, such as Ice Forecasting, during which the DCP sensors may be continually changed until an optimal arrangement is found.

Several improvements in DCP.FOR can be recommended at this point. They are:

1. An interface to help the user modify the MASTER.DAT file. This would be a menu-driven program that would assist the user in a) defining the sensor arrangement at a new DCP site, b) displaying the sensor arrangement at any existing DCP site, and c) modifying the sensor arrangement at any existing site.

2. The maintenance of an Historical DCP Site Description File. This file would keep a record of the original DCP site description and record the modifications and the date they occurred. This would be especially valuable when raw data is reprocessed for a site that has undergone many modifications.

3. Interface DCP.FOR with the current Corps of Engineers standard Water Control Data systems, such as the Hydrologic Engineering Center's Data Storage System (HECDSS).

REFERENCE

Steinhart, J.S. and S.R. Hart (1968) Calibration curves for thermistors. *Deep Sea Research*, **15**: 497.

APPENDIX A

MASTER.DAT

```
PEORIA LOCKS & DAM
CRR4
CE748450
SUT
11,5,0,5,1
1,1.0,0.0,32000,0,0
3,1.0,0.0,32000,0,0
2,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,1
8,0.00894,0.0,32000,0,0
9,0.108,0.0,32000,0,0
15,0.016,-30.0,32000,0,0
7,0.020,940.0,32000,0,0
5,0.020,0.0,32000,0,0
6,0.2789,0.0,32000,0,0
13,0.1,0.0,32000,0,0
0.12827895D-2,0.23650902D-3,0.92066156D-7
STARVED ROCK LOCKS & DAM
CRR5
CE748A82
SUT
6,5,0,5,1
1,1.0,0.0,32000,0,0
4,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,1
3,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
13,0.1,0.0,32000,0,0
0.12827895D-2,0.23650902D-3,0.92066156D-7
LOCK & DAM 4
CHRP
CE17140E
SYN
8,9,4,2,3
20,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
1,1.0,0.0,32000,0,0
2,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,2
3,1.0,0.0,32000,0,0
4,1.0,0.0,32000,0,3
13,1.0,0.0,32000,0,0
0.12952512D-02,0.26086999D-03,0.14949041D-06
0.12787021D-02,0.26203906D-03,0.15618451D-06
0.12827895D-02,0.23650902D-03,0.92066156D-07
```

```
EMSWORTH LOCKS & DAM
EMSP
CE5F9560
SYN
11,12,4,2,2
20,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
1,1.0,0.0,32000,0,0
2,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,2
3,1.0,0.0,32000,0,0
15,0.016,-30.0,32000,0,0
6,0.2789,0.0,32000,0,0
8,0.00894,0.0,32000,0,0
9,0.108,0.0,32000,0,0
13,1.0,0.0,32000,0,0
0.12926785D-02,0.26119662D-03,0.14508807D-06
0.13001200D-02,0.26058645D-03,0.14634057D-06
MONTGOMERY LOCKS & DAM
MGYP
CE5FD8B8
SYN
8,9,4,2,3
20,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
1,1.0,0.0,32000,0,0
2,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,2
3,1.0,0.0,32000,0,0
4,1.0,0.0,32000,0,3
6,0.2789,0.0,32000,0,0
13,1.0,0.0,32000,0,0
0.12928752D-02,0.26118267D-03,0.14760117D-06
0.13118564D-02,0.25897952D-03,0.15045782D-06
0.12827895D-2,0.23650902D-3,0.92066156D-7
NEW CUMBERLAND LOCKS & DAM
NCUO
CE5FE3F0
SUT
12,9,4,9,2
20,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
20,1.0,0.0,32000,0,0
1,1.0,0.0,32000,0,0
2,1.0,0.0,32000,0,1
2,1.0,0.0,32000,0,2
3,1.0,0.0,32000,0,0
```

```
15,0.016,-30.0,32000,0,0
6,0.2789,0.0,32000,0,0
7,0.020,940.0,32000,0,0
8,0.00894,0.0,32000,0,0
9,0.108,0.0,32000,0,0
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MELDAHL LOCKS & DAM
CRR1
CE4D678E
SYN
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RACINE LOCKS & DAM
CRR2
CE747A06
SYN
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LETART ISLAND DCP
CRR3
CE7FFFBA
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MKLN
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HAN
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CNTN
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McALPINE LOCKS & DAM
MCPN
CE555FFE
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LOCK & DAM 26
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ALEXANDRIA BAY CG STA. ST.LAWRENCE R
ALEX
CE20104A
SYN
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0.12130812D-02,0.26806726D-03,0.17752302D-06
0.12710749D-02,0.26426609D-03,0.14607556D-06
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APPENDIX B

EMSP.JUN1988

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1988,182,02,   25.1,   25.1, 99999.,10464.3,    8.1, 99999.,     0.3,  987.2,    1.2,   31.0, 99999., 99999., 99999., 99999., 99999.
1988,182,03,   25.0,   24.9, 99999.,10458.0,    7.5, 99999.,     0.3,  987.4,    1.5,    8.0, 99999., 99999., 99999., 99999., 99999.
1988,182,04,   24.9,   24.9, 99999.,10460.3,    7.0, 99999.,     0.3,  987.3,    1.6,   20.9, 99999., 99999., 99999., 99999., 99999.
1988,182,05,   24.9,   24.9, 99999.,10469.5,    6.5, 99999.,     7.0,  987.5,    1.9,   37.7, 99999., 99999., 99999.,   13.2, 99999.
1988,181,22,   25.2,   25.2, 99999.,10473.2,   12.4, 99999.,     0.0,  988.2,    1.4,   21.3, 99999., 99999., 99999., 99999., 99999.
1988,181,23,   25.1,   25.1, 99999.,10456.5,   10.9, 99999.,     0.3,  988.0,    2.1,   39.8, 99999., 99999., 99999., 99999., 99999.
1988,181,24,   25.1,   25.1, 99999.,10461.5,    9.9, 99999.,     0.0,  987.4,    1.6,   13.6, 99999., 99999., 99999., 99999., 99999.
1988,182,01,   25.1,   25.1, 99999.,10466.2,    8.9, 99999.,     0.0,  987.1,    1.5,    7.1, 99999., 99999., 99999.,   13.2, 99999.
1988,181,18,   25.4,   25.4, 99999.,10482.0,   22.0, 99999.,   269.7,  986.2,    2.8,  353.9, 99999., 99999., 99999., 99999., 99999.
1988,181,19,   25.4,   25.3, 99999.,10469.8,   20.2, 99999.,   109.6,  987.7,    3.1,   16.7, 99999., 99999., 99999., 99999., 99999.
1988,181,20,   25.3,   25.3, 99999.,10458.4,   17.7, 99999.,     3.3,  988.3,    1.4,  349.5, 99999., 99999., 99999., 99999., 99999.
1988,181,21,   25.3,   25.2, 99999.,10488.7,   14.4, 99999.,     0.0,  988.4,    1.1,   21.0, 99999., 99999., 99999.,   13.2, 99999
1988,181,14,   25.5,   25.5, 99999.,10482.0,   22.1, 99999.,   683.0,  986.2,    4.0,  290.3, 99999., 99999., 99999., 99999., 99999.
1988,181,15,   25.5,   25.5, 99999.,10504.0,   22.9, 99999.,   619.4,  985.7,    3.4,  300.6, 99999., 99999., 99999., 99999., 99999
1988,181,16,   25.5,   25.4, 99999.,10474.5,   23.8, 99999.,   563.1,  985.5,    2.4,  355.6, 99999., 99999., 99999., 99999., 99999.
1988,181,17,   25.5,   25.4, 99999.,10496.4,   23.5, 99999.,   431.7,  985.6,    3.5,  323.7, 99999., 99999., 99999.,   13.2, 99999
1988,181,10,   25.3,   25.3, 99999.,10474.5,   19.2, 99999.,   598.0,  988.4,    2.4,  266.8, 99999., 99999., 99999., 99999., 99999.
1988,181,11,   25.4,   25.3, 99999.,10504.0,   20.2, 99999.,   670.5,  987.8,    6.5,  305.2, 99999., 99999., 99999., 99999., 99999
1988,181,12,   25.4,   25.4, 99999.,10474.5,   21.5, 99999.,   796.3,  987.4,    5.8,  302.1, 99999., 99999., 99999., 99999., 99999.
1988,181,13,   25.5,   25.4, 99999.,10474.5,   22.2, 99999.,   722.4,  986.6,    3.9,  313.1, 99999., 99999., 99999.,   13.2, 99999
1988,181,06,   25.3,   25.2, 99999.,10488.2,   15.0, 99999.,    42.7,  988.2,    1.1,   50.2, 99999., 99999., 99999., 99999., 99999
1988,181,07,   25.2,   25.2, 99999.,10488.2,   16.2, 99999.,    85.3,  988.4,    2.7,  306.7, 99999., 99999., 99999., 99999., 99999.
1988,181,08,   25.2,   25.2, 99999.,10488.2,   17.0, 99999.,   292.8,  988.9,    3.9,  298.1, 99999., 99999., 99999., 99999., 99999.
1988,181,09,   25.3,   25.2, 99999.,10481.0,   18.3, 99999.,   675.5,  988.8,    1.9,   40.6, 99999., 99999., 99999.,   13.2, 99999.
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